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# Assessment of Construction Productivity in the Context of Khulna City of Bangladesh

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**Abstract:** This paper examines the current state of construction productivity in Khulna, Bangladesh and major factors that influence the productivity. A questionnaire survey was distributed to various stakeholders and construction projects in Khulna city. Ten projects in Khulna were selected for productivity assessment and a total of 100 respondents participated for ranking the influencing factors. The data were then used to calculate the productivity, and relative important index which enabled the factors to be ranked. Factors influencing the construction productivity were analyzed using an RII method. The average productivity of formwork, concrete work, brickwork and plastering work in Khulna construction industry is 3.40 sqft/hr, 4.98 cft/hr, 1.82 cft/hr and 8.16 sqft/hr respectively. Analysis of these factors showed that the top five ranked factors affecting construction productivity are labor supervision, skilled labor, availability of materials, availability of equipment's and scheduling of work. Therefore, focus should be targeted on these factors to make the construction firms profitable as well as improving the progress in construction works.

**Keywords:** Construction, productivity, assessment, factors, Khulna

## 1. Introduction

Construction performance and productivity improvement are key focus areas in the construction industry for any nation. Therefore, it is a general objective of all construction firms to offer better value against low cost (Ayub, Thaheem, & ud Din, 2016). According to Gouett et al. (2011), labor costs depict a considerable amount of costs in construction sites. Harris & McCaffer (2006) claimed that labor cost represents 33% to 50% of total project cost. To decrease this, it is important to increase construction productivity by identifying the most critical factors affecting construction productivity (Gouett et al., 2011). Hannula (2002) defines productivity as the ratio of total output to total input. Low productivity is the main barrier to a successful project (Jarkas & Bitar, 2011). Having such a significant financial influence, the management of labor productivity becomes even more critical. Thus, it is important to get optimum productivity in order to maximize the profit. Besides, the measurement of labor productivity is also an issue faced by the construction industry. Therefore, it is important to examine the most important factors influencing construction productivity.

In Bangladesh, although the construction industry is growing in every city, the remarkable growth has started from the capital city Dhaka. Dhaka is the most densely populated city with a population of about 160 million. However,

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building construction technology has not developed to the extent that observed in developed countries (Ahmed, Siddiquee & Khan, 2012). A study of the assessment of construction productivity and identifying the most critical factors affecting productivity in the construction industry is well researched but still meagre in the context of Bangladesh's construction industry. Given that the resources available for addressing the identified constraint factors are limited, there is therefore a crucial need for a deeper level of analysis to identify the priority factors that the stakeholders should focus on to optimize the use of scarce resources and achieve the greatest improvement in productivity and performance. This study aims to investigate the onsite productivity constraint factors and analyse their relative levels of impact with a view to identifying the key factors that are worthy of closer attention and resourcing and access the construction productivity to see the present view and develop the productivity.

## 2. Literature Review

The term productivity has different meanings. Organisation for European Cooperation defines productivity as "the quotient obtained by dividing output by one of the factors of production. Productivity, in other word, also regarded as the same as efficiency, which is defined as "the ratio output energy divided by input energy" (Harris & McCaffer, 2006). Overall, an operational definition of productivity that fits well with the various approaches to defining the concept - and which draws upon the output-input paradigm - is 'the amount or quantity of output of a process per unit of resource input'. This aligns with similar definitions by Page (2010) and other authors. The following equation summarises the key features embodied in this definition.

$$\text{Productivity} = \text{Amount or quantity of output/Resource input} \quad (1)$$

Where,

Amount or quantity of output= Product (Quantity);
Service (Quantity);
Money (Revenue or value added).

And Resource input= Manpower (man-hour);
Money (value of input);
Materials (materials quantity).

Construction productivity refers to the amount or quantity of work output (i.e. quantity or dollar value of products, service or revenue generated) per unit of man-hours employed. An overall measure of productivity looks at the total output versus total input expressed in the benchmark units; alternatively, an indexed overall measure of productivity expresses the output and input in standard units. To measure productivity, we used the amount or quantity of work output per unit of man-hours employed.

The role of construction in the economy and its development indicates the need for continuous improvement of productivity performance in the industry. The economy, construction firms, clients and employees will benefit from a productive industry that uses resources efficiently, saves costs, is competitive and can contribute enormously to the country's growth. Firms prefer measures that are relevant to them in their operations. Productivity indicators enable firms and project managers to plan activities, control costs, motivate workers, evaluate performance, and guide company policy and action, and also those of their partners, to attain continuous improvement. Clients benefit from earlier project completion and lower costs. The features of a good productivity indicator include clarity, relevance to strategic goals, ease in the training of skills to measure and apply, low cost of data collection and analysis, reliability and comparability of data, and a high likelihood of its application.

Many researchers have investigated the topic of construction productivity. It is important to set what factors influence construction productivity positively or negatively (Enshassi et al., 2007). If factors significantly affecting construction productivity are recognised, it will also be feasible to forecast productivity (Lema & Samson, 1995). In a survey carried out in the United States, material availability, tool availability, rework, overcrowded work areas and inspection delays were identified as major factors influencing productivity (Borcherding & Garner, 1981). In Oman, stakeholders who participated in a survey towards identifying the factors affecting productivity ranked errors and omissions in design drawings, change orders during execution, delay in responding to requests for information, lack of labor supervision, clarity of project specifications, coordination amongst design disciplines, working overtime, rework, inclement weather, labor's physical fatigue (Jarkas, Al Balushi, & Raveendranath, 2015). In India, the top five ranked factors affecting labor productivity are skilled labor, availability of material, availability of tools, labor supervision and safety conditions on-site (Ghate & Minde, 2016). In Spain, the top five ranked factors are as follows: shortage or late supply of materials, clarity of the drawings and project documents, clear and daily task assignment, tools or equipment shortages, level of skill and experience of laborers (Robles et al., 2014) Top three factors affecting the construction productivity in Malaysia are material shortage at a project site, non-payment ( financial problem) to suppliers causing the stoppage of material delivery to site and change order by consultants causing project delay (Kadir et al., 2005). In Thailand, the five most significant factors influencing construction productivity are lack of material, incomplete

drawing, incompetent supervisors, lack of tools and equipment's and absenteeism (Makulsawatudom, Emsley, & Sinthawanarong, 2004).

## 3. Methodology

This study employed survey method where data is obtained through interviews and questionnaire surveys. The questionnaire was designed around factors influencing construction productivity collected from various studies and expert interviews. The survey takes 15 factors propagated based on related research works on construction productivity.

The structured questionnaire was built of two parts:

a) The first part included the productivity measurement.
b) The second part included a table, which represents 15 factors influencing construction productivity in Khulna. The questions were designed using a five-point Likert scale comprising ratings from 1 to 5. The respondents were said to give the range to which factor impacted construction productivity in their projects.

### 3.1 Study Area

This study was conducted at six chosen areas namely Khulna University of Engineering and Technology, Fulbarigate, Boira, Sonadangha, Nirala and New market. As shown in Fig 1. These areas are situated in the Khulna division, the southern part of Bangladesh.

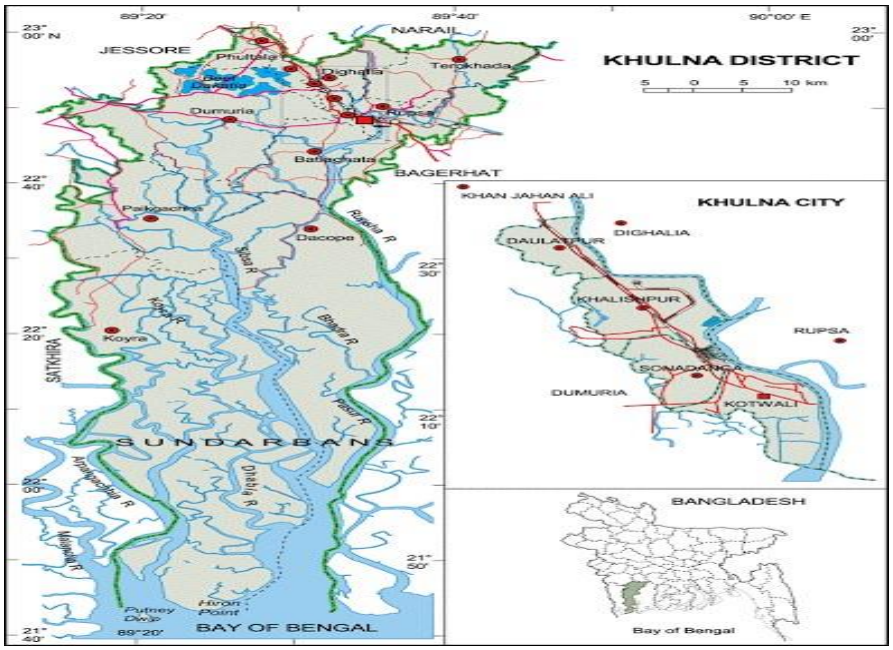


**Fig. 1 - Location of study areas in Khulna city of Bangladesh**

### 3.2 Data Collection

Face to face survey was conducted among both public and private construction projects for collecting information in the Khulna city of Bangladesh. Two types of survey were done for this research. For productivity assessment, four types of work items were selected for the survey and ten projects were selected for this assessment. On the other hand, fifteen factors were selected by literature reviews and experienced opinions for the survey. The data was collected from 100 respondents in different projects in the Khulna city for the factors influencing construction productivity. Both types of data was collected by interviewing people on the site, making questionnaires, talking with project managers, site engineers, architects, contractors, subcontractors, owners, and foremen.

### 3.3 Data Analysis

To analyse the data collected from the questionnaires, equation (2) was used to access the construction productivity in different types of work.

$$\begin{aligned} \text{Productivity} &= \text{Output} \div \text{Input} \\ &= \text{Total output} \div \text{Total work hour} \end{aligned}$$

$$= \frac{\text{Total Output}}{\text{Man} * \text{Work hour}} \quad (2)$$

Also, the data collected from the respondents for factors affecting productivity Relative Important Index (RII) method was used to analyse the ratings. This study used a likert scale rating of influence level from 1 to 5 where 1 stands for "Very less" and 5 for "Very high" influence of the factors collected via the face-to-face questionnaire survey. This study aimed to rank factors influencing productivity in Khulna according to their importance. For each factor, the RII was calculated using equation (3):

$$RII = \frac{\sum W}{AxN} \quad (0 \leq \text{index} \leq 1) \quad (3)$$

Where, W = weighting of each factor given by respondents; A = highest weight, which is 5 for this study, and N = total number of respondents. Calculated RIIs range in value from 0 to 1 (0 not inclusive), indicating that the higher the RII, the more important was the factor.

## 4. Results and Discussion

Most respondents (97%) were male, which is not surprising because the construction industry in Bangladesh has traditionally male-dominated. Project managers, site engineers, architects, contractors, subcontractors, owners and foremen were the participants in this study. The detailed result of productivity of formwork in the construction industry is shown in Table 1. There were some variations of productivity of formwork in different projects. As presented in the Table, project C showed the highest productivity of formwork with 3.71 sqft/hr. In project B, the lowest productivity was found 3.11 sqft/hr. However, the average productivity of formwork was 3.40 sqft/hr. Based on the results, the range of productivity of formwork in the construction industry in Khulna was 3.11 sqft/hr to 3.71 sqft/hr. This variation in productivity may be occurred due to good (or less) supervision of labor in measuring their works.

**Table 1 - Productivity of formwork**

| Project Name | Total Work (sqft) | Total Time (hr) | Productivity(sqft/hr) | Average |
|---|---|---|---|---|
| A | 7120 | 2190 | 3.25 | |
| B | 3125 | 1004.5 | 3.11 | |
| C | 5024.4 | 1355 | 3.71 | |
| D | 6804 | 2080 | 3.27 | 3.40 |
| F | 5115 | 1505 | 3.40 | |
| G | 6525 | 1945 | 3.35 | |
| H | 4635 | 1270 | 3.65 | |
| I | 5484 | 1584 | 3.46 | |

Table 2 illustrates the detailed result of the productivity of concrete work in the construction industry. According to the table, project C showed the highest productivity of concrete work, with 6.14 cft/hr, whereas, the lowest productivity was found in Project F, with 4.05 cft/hr. This high value indicates that it took more time to complete the project and hence caused cost overrun to occur. The average productivity of concrete work was 4.98 cft/hr. To summarise, the range of productivity of concrete work in the construction industry in Khulna was 4.05 cft/hr to 6.14 cft/hr.

**Table 2 - Productivity of concrete work**

| Project Name | Total Work (cft) | Total Time (hr) | Productivity (cft/hr) | Average |
|---|---|---|---|---|
| A | 6588 | 1113.5 | 5.92 | |
| B | 2260 | 437.5 | 5.17 | |
| C | 3255 | 530 | 6.14 | |
| D | 5380 | 1265 | 4.25 | 4.98 |
| F | 1684 | 416 | 4.05 | |
| G | 2978 | 680 | 4.38 | |
| H | 1760 | 308 | 5.71 | |
| I | 3011 | 716 | 4.21 | |

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Table 3 shows the result of the productivity of brickwork in the construction industry in Khulna city. There were some variations of productivity of brickwork in different projects. As shown in the Table 3, Project C and E represented the highest productivity of brickwork, respectively, with 1.89 cft/hr. Moreover, the lowest productivity was found in project A, with1.68 cft/hr. In addition, the average productivity of brickwork was 1.82 cft/hr. The variation of productivity may be occurred due to good (or less) supervision of labor. According to the Table 3, the range of productivity of brickwork in the construction industry in Khulna is between 1.68 cft/hr to 1.89 cft/hr.

**Table 3 - Productivity of brickwork**

| Project Name | Total Work (cft) | Total Time (hr) | Productivity (cft/hr) | Average |
|---|---|---|---|---|
| A | 237.5 | 141 | 1.68 | |
| C | 333.33 | 176 | 1.89 | |
| E | 242.5 | 128 | 1.89 | 1.82 |
| F | 550 | 295 | 1.86 | |
| G | 187.5 | 105 | 1.79 | |
| J | 198.75 | 110 | 1.81 | |

Table 4 illustrates the result of the productivity of plastering work involving six projects in the construction industry in Khulna. Project E represented the highest productivity of plastering work, with 9.39 sqft/hr. Project C showed the lowest productivity, with 6.49 sqft/hr. The average productivity of plastering work was 8.16 sqft/hr, and the range of productivity of plastering work in the construction industry in Khulna was between 6.49 sqft/hr to 9.39 sqft/hr. The main factors influencing this variation were labor supervision, skilled labor, availability of materials, safety conditions on-site, as well as climatic conditions.

**Table 4 - Productivity of plastering work**

| Project Name | Total Work (sqft) | Total Time(hr) | Productivity (sqft/hr) | Average |
|---|---|---|---|---|
| A | 538.5 | 58 | 9.28 | |
| C | 2167 | 334 | 6.49 | |
| E | 694.5 | 74 | 9.39 | 8.16 |
| F | 480 | 57 | 8.42 | |
| G | 600 | 80 | 7.50 | |
| J | 2598 | 329 | 7.90 | |

As shown in Table 5, labor supervision was ranked first as compared to other factors, with an RII of 0.868. Inadequate supervision of laborers work might be the plausible reason for the low productivity. With an RII 0.814, skilled labor was ranked second as a factor affecting productivity. As such, consultancy firms, as well as Government, should take some necessary steps to make skilled labor for increasing productivity. Availability of materials as a factor was ranked third in respect of its impact on construction productivity, with an RII of 0.77. The owners demanded that this is happened due to the contractor's liquidity problems to purchase the materials. With an RII of o.746, availability of equipment was ranked fourth as a factor influencing the productivity. For increasing productivity, the event of lack of equipment can be reduced by adding preventive maintenance. With a RII of 0.714, scheduling of work was ranked fifth, as a critical factor influencing the construction productivity. An inappropriate schedule reduced productivity due to letting the work incorrect time. For climatic conditions (RII: 0.662) such as hot and cold weather, rain decreased the construction productivity. Consultancy firms and Government should take necessary steps to give the training of laborers (RII: 0.594) to improve productivity. In order to solve the miscommunication (RII: 0.51) problem, respondents suggest that instead of informal verbal communication, documentation should be used. Unscheduled extra work was ranked eleventh as the critical factor affecting the construction productivity with an RII of 0.494.

The more extra work, the more time and cost are needed for construction. Causes of extra work/rework can be attributed mainly to incompetent craftsmen and incompetent supervisors. Further, respondents ranked the structural design complexity factor twelfth, as a crucial factor affecting the construction industry, with an RII of 0.434. By implementing experienced engineers, supervisors and foremen were selected, the respondents were confident the effect of structural design complexity on productivity could be much reduced. The site layout was ranked thirteenth, with an RII of 0.382, regarding its significance on construction productivity. Poor site layout interrupts workflow, for example, material search difficulties, equipment transportation difficulties or access problems.

**Table 5 - Survey response result with RII**

| Factors | RII | Rank |
|---|---|---|
| Labor Supervision | 0.868 | 1 |
| Skilled Labor | 0.814 | 2 |
| Scheduling of Work | 0.714 | 5 |
| Training of Labor | 0.594 | 8 |
| Climatic Condition | 0.662 | 6 |
| Unscheduled Extra Work | 0.494 | 11 |
| Availability of Materials | 0.77 | 3 |
| Availability of Equipment | 0.746 | 4 |
| Numbers of Labor on Site | 0.61 | 7 |
| Site Layout | 0.382 | 13 |
| Miscommunication between Stakeholders | 0.51 | 10 |
| Changes of Work | 0.562 | 9 |
| Structural Design complexity | 0.434 | 12 |
| Construction method | 0.378 | 14 |
| Safety conditions on site | 0.662 | 6 |

## 5. Conclusion and Recommendations

In most countries, performance and productivity improvement are two focus areas in the construction industry. To ensure project productivity is optimised, construction firms increase their profit and market competitiveness by controlling project costs such as labor, material, equipment and overhead cost. Despite its importance, construction productivity remains the least studied area in the context of Bangladeshi construction industry. Hence, this study provides the assessment of construction productivity in Khulna city. To achieve this, ten projects in Khulna were selected for productivity assessment and a total of 100 respondents participated for ranking the influencing factors. The results show that productivity was found in the Khulna construction area. In particular, the average productivity of formwork, concrete work, brickwork and plastering work in Khulna was 3.40 sqft/hr, 4.98 cft/hr and 8.16 sqft/hr, respectively.

Also, this paper shows that the top five factors affecting construction productivity are labor supervision, skilled labor, availability of materials, and availability of equipment's and scheduling of work. Labor supervision is a factor that highly affects construction productivity and with skilled labor, work can be done in less time without compromising the quality of work. Availability of materials was ranked third in respect of its impact on construction productivity. The owners demanded that this is principally due to the contractors' liquidity problems to purchase the materials. Improvement of construction productivity in Khulna should be now focused on these factors, since this will not only ensure the construction firms profitably but also increase the progress in the projects. Since this study covered only the Khulna city area, we suggest future research to explore it could be expanded to the whole of Bangladesh in order to find out the national productivity rate. The skilled site staff and experienced builders should be deployed to improve the productivity of Khulna city. To increase the productivity of Khulna city, a training and safety improvement program should be incorporated in the contract by the various stakeholders.

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